where a multiplicity of unknown or unanalyzed causes ("accidents," pp. 19, 55) determines some mathematically measurable quality. Eye colour, artistic faculty, and temper, to which Mr. Galton applies his method, are not mathematically measurable qualities, and his results, self-consistent though they are, are scientifically untrustworthy because of variation in the standard of popular judgment in such matters. Stature, however, comes properly within the range of his method, and Mr. Galton has made the most of this point.

The method employed by Mr. Galton may be styled a mathematical interpretation of the law of uniformity of nature as apparent in the tendency of progression and regression to an average for all new examples of measurable qualities. (By the way, it is curious that Mr. Galton does not employ the term progression, instead of making regression cover all movements both upward and downward to an average. Rise to an average is certainly progress.) The comparatively easy method of average in dealing with such problems as heredity in the lump is hardly, what Mr. Galton claims it to be, the pioneer method in the "science of man" (p. 62). Indeed, the method of chance is infertile in both biology and sociology so far as it mistakes statements of average tendency as in any wise comparable in value to the particular predictions given by inductive inquiry. The continued use of such terms as accident and chance to cover a multitude of undetermined particular causes may be directly hurtful so far as this tends to slur over the patient investigation of special cases. The greatest so-called accidental variations, or "sports," have, of course, their reason in a peculiar conjuncture of influences, and the exact determination of these, specially with reference to stable stocks, would be of the greatest scientific and practical value. The method of chance can never be an aid to progress, for it always fails in particular predictions, and reduces our outlook to the level plain of averages.

In a book on natural inheritance we should expect some thorough treatment of the relation of heredity to other factors, and a clear exposition of how it can be isolated from them in its effect, especially upon stature. But the statistics employed are avowedly statistics of stature and not of heredity: how, then, are the results made to stand not merely for stature but also for heredity? Mr. Galton concludes that his results for stature are really laws of heredity because of the peculiar relations of the ratios obtained (p. 132), and also because the results are confirmed by general deductions from the laws of chance (p. 102). But as to this first point we must regard it as assumed rather than proved that kinship is to be measured by the comparison of ratios of deviations amongst kin. If we knew from other investigations or *a priori* that the influence of heredity on regression is in the numerical order given, then Mr. Galton's results would be merely confirmatory evidence. The laws of heredity must be based on the facts of heredity, or it must be clearly shown by the method of elimination that given results can only be ascribed to heredity. Does Mr. Galton accomplish this? He slurs over other influences than heredity (*e.g.* education, p. 156), or he hastily concludes them to be in harmony with heredity (*e.g.* natural selection, p. 119). He also does not satisfy us on the equal influences of parents in heredity (p. 98), which is a fundamental assumption for his process. That the average regression of the son to the general average of stature is by one-third parental deviation (p. 104) does not, on the face of it, prove anything with regard to transmission of stature. I cannot see that Mr. Galton has clearly shown this ratio to be more than a law of stature as determined by all influences and not by heredity alone. To make the ratios obtained a "measure of family likeness" (p. 132) is certainly unproved till it is shown that heredity alone enters into the data upon which the ratios are founded. It is plain that in any case, whether the cause be heredity alone or heredity plus many other influences, certain definite ratios will be obtained for father, son, brother, &c.

As to the way in which an abstract calculation of the laws of chance confirms Mr. Galton's statistics, it is enough to observe that no evidence is adduced why the results attained should not stand for the multiple "accidents" of environment, nourishment, occupation, heredity, &c., rather than to "accidents" of heredity alone. Mr. Galton fails to prove that his ratios are not the mathematical expression for the operation of the law of frequency of error as applied to the chance operation of heredity plus other agencies, rather than the formula for heredity simple and unadulterated.

But stature is undoubtedly modified by many prenatal conditions which do not come under the head of heredity, and it is certainly modified by climate, nourishment, and occupation. It is quite likely that human dwarfs might be raised upon the same principles as the Japanese dwarf trees. Mr. Galton makes no deduction from his statistics for other influences than heredity, and his results stand as the expression of the law of frequency of error applied to qualities which are the effect of many complex causes beside heredity. HIRAM M. STANLEY.

Lake Forest University, October 5.

Head Measures at Cambridge.

I AM pleased to be able to say, with reference to criticisms by your correspondents on the trustworthiness of the head measures at Cambridge, and on the deductions made by myself from the results obtained by Dr. Venn after he had discussed the first batch of them, that he is now about to discuss a second batch. The observations that have since accumulated are about equal in number to those already dealt with, and the new results will afford an efficient check upon the value of those already published. I hope also that Dr. Venn may find adequate material to determine the "probable error" of a single head measure, by means of the differences (discussed under obvious restrictions) between the recorded measures of the same persons at different times. We shall then be better able than we are now to estimate the degree of reliance to be placed on the mean value of any given number of head measures. FRANCIS GALTON.

Trimorphism in *Scabiosa succisa*.

THIS species is usually described as gynodiœcious. Hooker ("Student's Flora") thus refers to it. Darwin ("Forms of Flowers") says, "I have observed the existence of two forms in our endemic *S. succisa*"; further, "From what Lecoq says ('Géographie Botanique') *S. succisa* appears to occur under two forms in France"; and again, "According to Lecoq, the female flower-heads of *S. succisa* are smaller than those of what he calls the male plants, but which are probably hermaphrodites." Hermann Müller ("Fertilization of Flowers") also speaks of *S. succisa* as existing under two forms in Germany.

I have recently discovered that the species really exists, in this country at least, under three very distinct forms, viz. (1) the original hermaphrodite; (2) the small female form described by Lecoq; and (3) a second female form, larger even than the hermaphrodite, and differing from the first in a very remarkable manner. I will describe the three forms in detail.

No. 1 (hermaphrodite). Average measurements of 100 capitula: diameter at the base $\frac{13}{16}$ inch, height $\frac{17}{32}$ inch. Average number of florets per capitulum 86 (highest 111, lowest 53). Corolla lavender. Filaments incurved in bud, afterwards erect, and twice as long as the corolla-tube. Anthers pink. Style about $\frac{7}{16}$ inch long, thin, remarkably erect, purple, glabrous. Plane of stigma at right angles to the style. Development of style does not take place till anthers have fallen, when stigma becomes viscid.

No. 2 (straight-styled female). Average measurements of 50 capitula: diameter $\frac{5}{8}$ inch, height $\frac{3}{8}$ inch. Average number of florets 61 (highest 79, lowest 52). Florets very small. Corolla with a deep lilac tinge. Stamens abortive, filaments very short, within the tube. Rudimentary anthers yellow. Style about $\frac{3}{8}$ inch long, otherwise precisely as in No. 1, but development begins as soon as the floret opens.

No. 3 (bent-style female). Average measurements of 150 capitula: diameter $\frac{7}{8}$ inch, height $\frac{9}{16}$ inch. Average number of florets 58 (highest 79, lowest 22). Florets very large, and more loosely packed on the receptacle. Corolla blue, with a lavender tinge. Stamens as in No. 2. Style about $\frac{9}{16}$ inch long, very stout, much swollen at the base (? honey-gland), usually white, stigma green. Plane of the stigma much inclined. Styles much bent and twisted. The whole surface of the corolla clothed with long stellate hairs. These are thickest on the face of the limb, which in the other forms is quite glabrous. The style is also thickly covered with similar hairs, which are much crowded immediately below the stigma. To these hairs an immense number of pollen-grains may be found adhering. The hairs are not fully developed until the stigma is mature.

Forms in some respects intermediate between Nos. 1 and 2, and between Nos. 1 and 3, are occasionally found, and this

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might be expected, as Nos. 2 and 3 are obviously descended from the hermaphrodite No. 1. I have never, however, found a single individual in any sense intermediate between Nos. 2 and 3, which appear to be two distinct female forms developed from No. 1 along different lines.

These two forms, it will be observed, differ remarkably from each other in the following points, viz. size of capitulum, size of florets and arrangement on the receptacle, colour of corolla, stoutness, colour and general form of style, and in the absence or presence of stellate hairs.

The stellate hairs are utilized to catch stray pollen-grains detached from the bodies of insect-visitors coming from neighbouring hermaphrodites, most of which would otherwise be wasted. As it is, they are retained by the hairs until the arrival of other insects, which in depressing the already bent and twisted styles bring their viscid stigmas into contact with the pollen-grains collected by the hairs of adjacent florets—a result facilitated by the manner in which the stigma is set on the style. By this arrangement the chances of fertilization are much increased, as each stigma generally receives a full share of pollen.

With regard to the relative size of the three forms it is remarkable that while one of the female forms is so much smaller than the hermaphrodite (as is the case, according to Darwin, in all gynodiœcious species known to him), the other even exceeds it in size. It is also noteworthy that the capitulum of the second female form, although larger than that of the hermaphrodite, contains a much smaller number of florets, and these are very large.

I can discover no rule as to the distribution of the different forms. In one station near here (a large common) all the plants are hermaphrodites. In a certain wood where the species abounds, the "bent-styled" females appear to be nearly as common as the hermaphrodites, while no "straight-styled" females can be found. In another wood, not half a mile distant from the first, the "bent-styled" form is almost entirely supplanted by the "straight-styled," which is plentiful. Lastly, in a fourth station (a barren strip of ground by the roadside), all three forms are found growing together. ARTHUR TURNER.

Box Hill, September.

On the Aquatic Habits of Certain Land Tortoises.

IT has always proved of more or less interest to me to observe the method of aquatic locomotion adopted on the part of any of our strictly terrestrial vertebrates, and never is this more keen than when the opportunity has been afforded to study the swimming propensities of certain of our Reptilia. Most snakes swim well, but who of us has not been surprised upon first observing the violent wriggling, froward-propelling motions of some of the smaller lizards when they are thrown out into the water some little distance from the shore? The American chameleon (*Anolis principalis*) well illustrates this last; and this lizard, in common with others, seems to possess an actual dread of getting into deep water. For a long time it has been known that most species of the so-considered stricter types of land tortoises soon drown when placed in water of any considerable depth, and it would be but natural to suppose that such species would avoid that element as far as possible, but I have found this by no means always to be the case. Take the ordinary land turtle of the United States (*Cistudo carolina*, for example: it will voluntarily enter the water under certain circumstances. Not long ago the writer noticed one of these hunting for food in three or four inches of water along the edge of a pond that had rising banks; and the first time I discovered the nest of this variety the eggs were deposited in the water in a depression at the miry margin of a marsh. But this is not all, for if we place one of these reptiles upon a little island of land, well removed from the shore, and surrounded by water several feet in depth, and withdraw to watch its movements, we note that as soon as it satisfies itself as to its position, it will, without further ado, take at once to the water and swim to the nearest shore. It does not, however, sink beneath the surface, but, holding its head high out of that element, and filling its lungs with air, strikes out vigorously, with alternate pairs of feet, until it accomplishes its purpose, and regains the mainland. How far one could swim in this manner I am unable to state, but that it would not exceed a few yards I am quite certain. Nevertheless, even the power to accomplish the feat to the extent indicated might, under a variety of circumstances, have its influence upon the distribution of the species, or of any species of typical land tortoise, and it would be interesting to know how far this power may be enjoyed by this class of reptiles generally.

Smithsonian Institution, R. W. SHUFELDT.
Washington, D.C., September 13.

Delambre's Analogies.

FOUR of the most important formulæ in spherical trigonometry were given by Gauss, without proof, in his "Theoria Motus Corporum Cœlestium" (1809), and were therefore called Gauss's theorems or analogies.

They were, however, given by Mollweide in Zach's *Monatliche Correspondenz* for November 1808, and before that by Delambre in the *Connaissance des Temps*, issued in April 1807, so that they are now justly ascribed to the latter.

They may be deduced in the most simple manner from Napier's analogies, and thus easily remembered.

Napier's analogies are—

$$\tan \tfrac{1}{2}(A + B) = \frac{\cos \frac{1}{2}(a - b)}{\cos \frac{1}{2}(a + b)} \,.\, \cot \tfrac{1}{2}C \qquad (\alpha)$$

$$\tan \tfrac{1}{2}(A - B) = \frac{\sin \frac{1}{2}(a - b)}{\sin \frac{1}{2}(a + b)} \,.\, \cot \tfrac{1}{2}C \qquad (\beta)$$

$$\tan \tfrac{1}{2}(a + b) = \frac{\cos \frac{1}{2}(A - B)}{\cos \frac{1}{2}(A + B)} \,.\, \tan \tfrac{1}{2}c \qquad (\gamma)$$

$$\tan \tfrac{1}{2}(a - b) = \frac{\sin \frac{1}{2}(A - B)}{\sin \frac{1}{2}(A + B)} \,.\, \tan \tfrac{1}{2}c \qquad (\delta)$$

$$\text{Let } m \,.\, \sin \tfrac{1}{2}(A + B) = \cos \tfrac{1}{2}(a - b) \cos \tfrac{1}{2}C \,. \qquad (1)$$

$$\therefore\ m \,.\, \cos \tfrac{1}{2}(A + B) = \cos \tfrac{1}{2}(a + b) \sin \tfrac{1}{2}C \,. \qquad (2)$$

These are numerator and denominator of (α).

$$\text{Let } n \,.\, \sin \tfrac{1}{2}(A - B) = \sin \tfrac{1}{2}(a - b) \cos \tfrac{1}{2}C \,. \qquad (3)$$

$$\therefore\ n \,.\, \cos \tfrac{1}{2}(A - B) = \sin \tfrac{1}{2}(a + b) \sin \tfrac{1}{2}C \,. \qquad (4)$$

Numerator and denominator of (β).

Square, and add—

$$\therefore\ m^2 + n^2 = 1.$$

Divide (4) by (2), and it follows by (γ) that—

$$\frac{n}{m} = \tan \tfrac{1}{2}c\,;$$

$$\therefore\ m = \cos \tfrac{1}{2}c,\ n = \sin \tfrac{1}{2}c.$$

Substitute these values, and (1), (2), (3), (4), are Delambre's analogies. R. CHARTRES.

Classified Cataloguing.

THE principle suggested by Mr. Petrie, on "Classified Cataloguing" (NATURE, August 22, p. 392), is already successfully used in many of the chief libraries of the United States, having been originated by Mr. Melville Dewey, while Librarian at Amherst College. It is equally applicable to collections of all kinds, and the classification has already been extended to a considerable extent in certain departments, particularly in botany, and is capable of unlimited extension. It possesses all the advantages mentioned by Mr. Petrie, but is broader, inasmuch as it includes all subjects.

In the "Decimal Classification" of Mr. Dewey (Boston, 1885, second edition), we find, for illustration, under 500, General Science; 580, Botany; 583, Dicotyledonæ; 583·9, Apetalæ; 583·95, Unisexuales, 583·951, Euphorbiaceæ; 590, Zoology; 598, Reptiles; 598·13, Chelonia, &c.

If an extension of this system, which would, I have the means of knowing, be most acceptable to Mr. Dewey, were to be adopted for general museum use, the advantages would be incalculable. JAS. LEWIS HOWE.

Polytechnic Society, Louisville, Kentucky.

Valuable Specimens of Vertebrates for Biological Laboratories.

WHAT specimens of Vertebrates are the best to be used by the student in the biological laboratory? This is certainly a very important question. In Europe, the following animals are generally dissected: some fish, the common frog, the pigeon,

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